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PIERCE POWER DAM (NH..(U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV FEB 79

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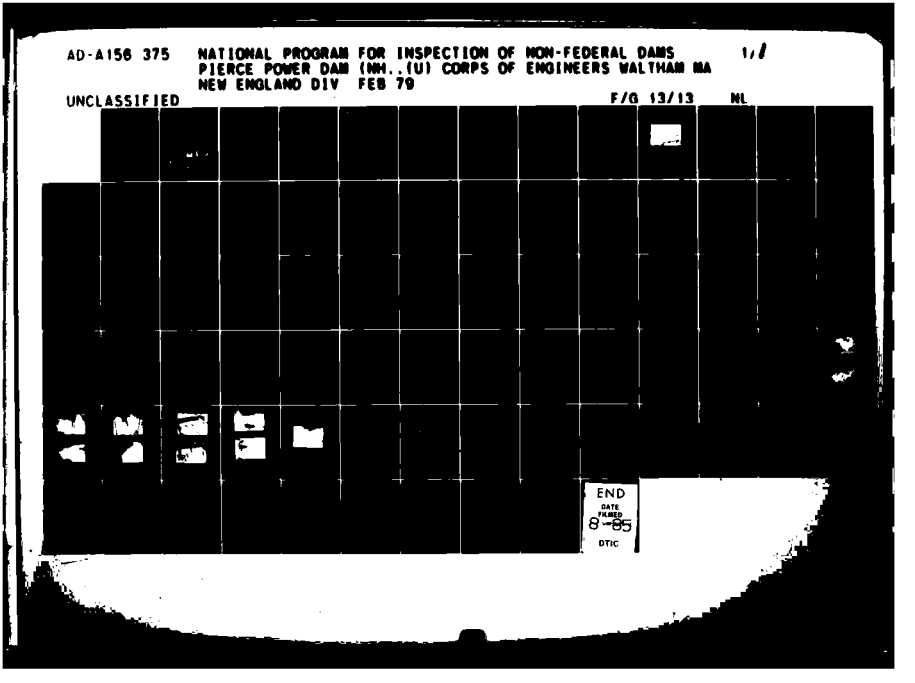

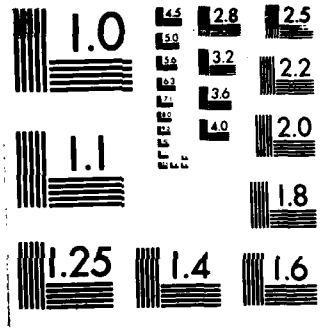

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PEACE POWER DAM
NH 00250

STATE NO 2204

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Bennington, New Hampshire
Contoocook River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam has a hydraulic height of 28 ft. and is 420 ft. long. It is a run of the river , concrete counterfort combined with a concrete gravity dam. The dam is in poor condition with some major concerns. It is small in size with a significant hazard potential. A major breach at top of dam would probably result in the loss of 3 to 4 lives and appreciable damage.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

SEP 29 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

I am forwarding to you a copy of the Pierce Power Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Monadnock Paper Mills, Bennington, New Hampshire 03442.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00250
Name of Dam:	Pierce Power Dam
Town:	Town of Bennington
County and State:	Hillsborough County, New Hampshire
Stream or River:	Contoocook River
Date of Inspection:	November 20, 1978

BRIEF ASSESSMENT

Pierce Power Dam has a hydraulic height of 28 feet, is of varied width, and is 420 feet long. It is a run-of-the-river, concrete counterfort combined with a concrete gravity dam. The spillway sections are 11 feet high and 168 and 122 feet long respectively, totaling 290 feet; 2-foot flashboards have been installed. It has a leaf sluice and three head gates to control discharge through two turbines installed in the powerhouse. The dam spans a reach of the Contoocook River, and is located in south central New Hampshire. Pierce Power Dam, used for hydropower purposes, has a storage capacity of about 51 acre-feet. The pond is 900 feet in length with a surface area of about 7 acres.

The dam is in poor condition. Major concerns are: a 50-gpm leak and/or seep west of the powerhouse and deteriorated concrete in the dam and appurtenant structures. Minor concern is the failure of the most downstream section of the training wall at the east end of the spillway.

Based on a small size and significant hazard potential classifications in accordance with Corps guidelines, the test flood is 1/4 Probable Maximum Flood (PMF). A test flood outflow of 15,760 cfs (about 83 csm) would overtop the dam by about 0.6 foot (5.1 feet over spillway crest without flashboards). The spillway will pass 10,245 cfs or about 65 percent of the test flood. A major breach at top of dam would probably result in the loss of 3 to 4 lives and appreciable property damage.

The owner, Monadnock Paper Mills, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I inspection report; however, seepage monitoring should be implemented promptly.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Pierce Power Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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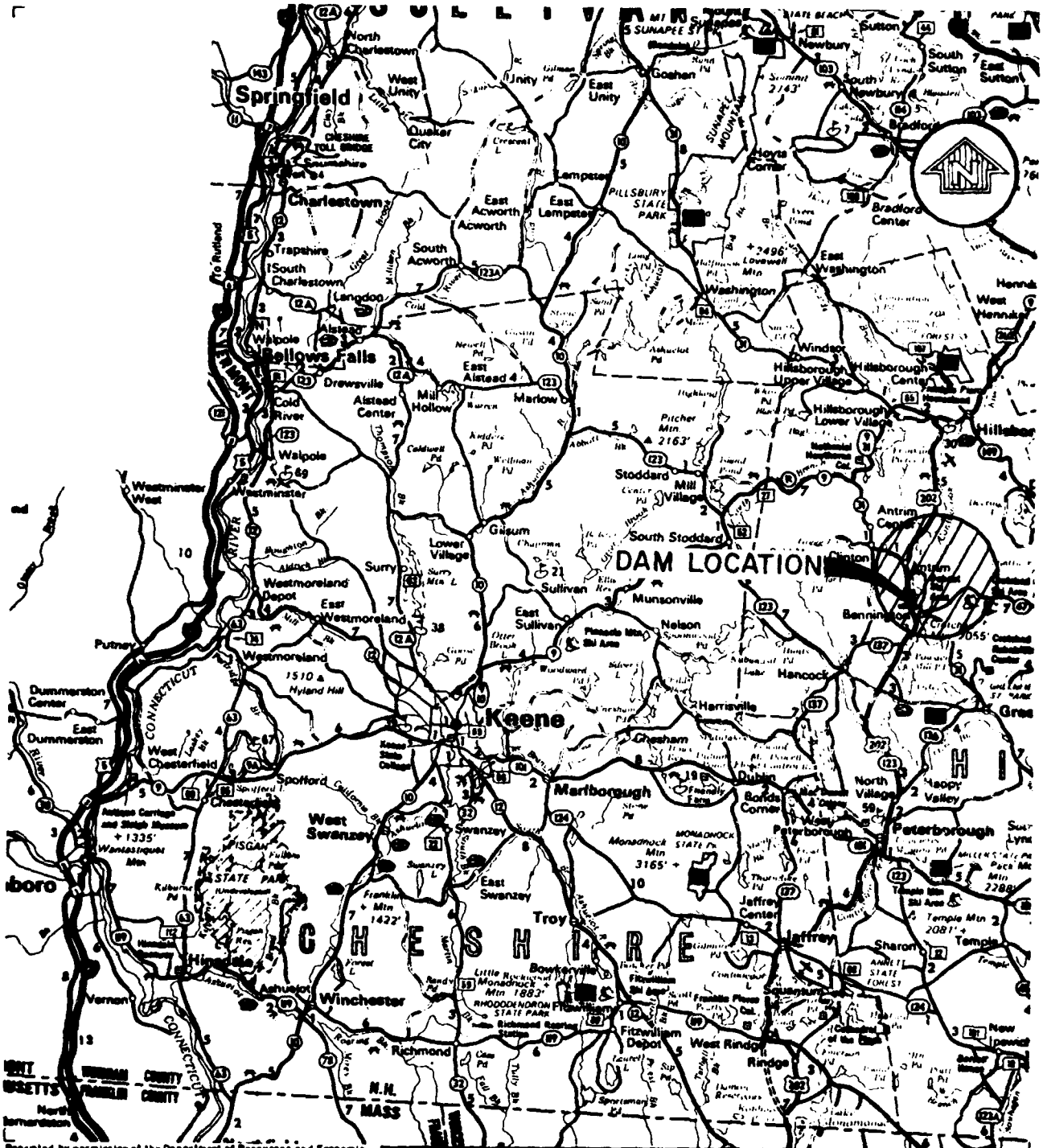
Figure 1 - Overview of Pierce Power Dam.



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Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PIERCE POWER DAM
LOCATION MAP

CONTOOCOOK RIVER — NEW HAMPSHIRE

SCALE: SEE BAR SCALE

DATE: FEBRUARY 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
PIERCE POWER DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Pierce Power Dam is located in the Town of Bennington, New Hampshire and is a run-of-the-river dam spanning the Contoocook River. After discharging over the dam, the Contoocook River flows northerly and then northeasterly for a distance of about 43 miles before becoming confluent with the Merrimack River in Concord, New Hampshire. The Contoocook River is a major tributary in the Merrimack River Basin. Pierce Power Dam is shown on U.S.G.S. Quadrangle, Hillsboro, New Hampshire with coordinates approximately at N 43° 00' 12", W 71° 55' 30", Hillsborough County, New Hampshire. (See Location Map Page vii).

b. Description of Dam and Appurtenances. Pierce Power Dam is a concrete dam about 28 feet high and 420 feet long. The spillway is about 290 feet long and consists of two sections: one section is a counterfort design with an inclined upstream face, about 168 feet long, extending eastward from the west abutment. A 6-foot triangular section about 24 feet long and resting on a concrete block about 26 feet long and 7 feet wide and extending to an unknown depth buttresses the dam at the west abutment. The other section is a conventional gravity section with a vertical downstream face about 122 feet long on a dogleg alignment, and extending from the counterfort section to the abutment wall west of the powerhouse. The east abutment of the dam is comprised of the powerhouse, and three head gates, 9'W x 12'H, located along the upstream side of the powerhouse. The gates are manually operated with control mechanisms located directly above each gate. Adjacent to the west side of the powerhouse is a 3' wide leaf sluice. Upstream of the sluice is a small wooden house that covers a float with electrical wires. (At one time this installation automated the gates.)

c. Size Classification. Small (Hydraulic Height - 28 feet; Storage - 51 acre-feet) based on height and storage ($<$ 40 feet and $\geq$ 50 to $<$ 1000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant hazard. A major breach would probably result in the loss of three to four lives and appreciable property damage. (See Section 5.1 f.)

e. Ownership. The Pierce Power Dam which exists today was built in 1921 by the Monadnock Paper Mills. The ownership has remained unchanged throughout the years. The original dam at this site consisted of an old stone powerhouse and wooden dam which was owned by the Antrim-Bennington Electric Light and Power Company. Monadnock Mills purchased the water rights at the damsite prior to 1921.

f. Operator. The current owner and operator of Pierce Power Dam is Monadnock Paper Mills, Bennington, New Hampshire 03442. Phone: (603) 588-3311.

g. Purpose of Dam. Pierce Power Dam was constructed to provide upstream storage for use in power generation for Monadnock Paper Mills. This purpose continues.

h. Design and Construction History. The original dam at the site consisted of an old stone powerhouse and a wooden dam. No details of this dam were found. In 1921 the existing dam was built. This dam was designed by Aberthaw Construction Company. One drawing prepared by Aberthaw Construction Company, titled "Plan and Sections, Concrete Dam, Monadnock Paper Mills",

dated 7/15/1921 and one untitled and undated preliminary plan were found in the files of the NHWRB. The preliminary plan shows the location of the new concrete dam in relation to an old timber dam, which it replaces and another concrete dam, located upstream, to which it is connected. With this construction two dams are practically combined into one. Inspection discloses that the alignment of the dam as shown on these plans represents the approximate alignment as it exists at the present time with the exception of that portion of the dam just to the west of the powerhouse. The existing alignment of the spillway and training wall at the east spillway abutment as disclosed by visual inspection are shown on the sketch in Appendix B.

i. Normal Operating Procedures. No written operating procedures were disclosed for Pierce Power Dam. The Contoocook River discharge to the damsite is primarily controlled by the Powder Mill Pond Dam, located approximately 5,100 feet upstream. Before reaching the Pierce Power Dam, the discharge from the Powder Mill Pond also flows over the Monadnock Power Station Dam located about 900 feet upstream. Monadnock Paper Mills own and control each of these dams. Generally, they operate the Powder Mill Pond Dam to provide sufficient discharge at the Pierce Power Dam for use in power generation; the power is supplied to their paper processing plant.

It is reported that every July the head gates are opened to release accumulated sediment which has built up behind the dam. This annual opening also permits inspection of the gates and the gate operating facilities.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 191 square miles (122,240 acres) of gently rolling terrain.

b. Discharge at Damsite.

(1) Outlet works (conduits) - Three head gates each 9'W x 12'H @ invert elevation 640.6' MSL. Head gate capacities - unknown (controlled by turbines).

(2) The maximum discharge at damsite - A U.S.G.S. gaging station with a drainage area of 368 square miles is located on the Contoocook River near Henniker, New Hampshire. A maximum discharge of 22,200 cfs was reported at this gaging station during the September 1938 flood. Using this figure, the maximum discharge at damsite can be interpolated to be approximately 12,500 cfs.

(3) Ungated spillway (without flashboards) capacity @ top of dam elevation - 10,245 cfs @ 655.9' MSL

(4) Ungated spillway (without flashboards) capacity @ test flood elevation - 12,360 cfs @ 656.5' MSL

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - 12,360 cfs @ 656.5' MSL

(8) Total project discharge @ test flood elevation - 15,758 cfs @ 656.5' MSL

c. Elevation (ft above MSL).

(1) Streambed at centerline of dam - 628.1 (at downstream toe of powerhouse); 640.9 (at downstream toe of spillway)

(2) Maximum tailwater - the maximum tailwater during the September 1938 flood is estimated to have been at elevation 637. (See Low Flow and Flood Profile, Page B-11.)

(3) Upstream invert leaf sluice - 653.4
Upstream portal invert head gates - 640.6

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 651.4 (without flashboards)

(7) Design surcharge (original design) - unknown (estimated to be 655.9)

(8) Top of dam - 655.9

(9) Test flood pool - 656.5

d. Reservoir (feet)

(1) Length of maximum pool - 900 (to Monadnock Power Station Dam)

(2) Length of pool at spillway crest - 900 to Monadnock Power Station Dam)

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 33 (approximate)

(4) Top of dam - 51 (approximate)

(5) Test flood pool - 53 (approximate)

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 7 (approximate)

(4) Test flood pool - 8 (approximate)

(5) Top of dam - 7 (approximate)

g. Dam

(1) Type - concrete counterfort section combined with gravity section having inclined upstream and vertical downstream spillway faces.

(2) Length - 420'

(3) Height - 30' (structural height)

(4) Top Width - varied

(5) Side Slopes - vertical downstream; inclined upstream at 1H:1V in part; upstream remainder unknown, though possibly all inclined at 1H:1V.

(6) Zoning - not applicable

(7) Impervious core - not applicable

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable (See j.)

i. Spillway

(1) Type - concrete counterfort joined with concrete gravity section

(2) Length of weir - 290'

(3) Crest elevation - 651.4' MSL (without flashboards)

(4) Gates - none (has flashboards about 2' high in part)

(5) U/S Channel - The approach channel to the dam consists of the Contoocook River about 150 feet in average width; the channel is open and the banks are tree lined. The State Route 31 highway bridge is located about 450 feet upstream.

(6) D/S Channel - The channel downstream of the spillway consists of large boulders and bedrock and is wide and unobstructed. Downstream of the powerhouse is a narrower tree lined tailrace which joins the main channel about 600 feet downstream of the dam.

j. Regulating Outlets. The powerhouse forms the east abutment of the dam with three 9'W x 12'H headgates at invert elevation 640.6' MSL located along its upstream (south) side. All gates are manually operated with operating mechanisms located directly over each gate.

SECTION 2
ENGINEERING DATA

2.1 Design

No engineering design data were disclosed for Pierce Power Dam.

2.2 Construction

One drawing prepared by Aberthaw Construction Company, titled "Plan and Sections, Concrete Dam, Monadnock Paper Mills", dated 7/15/1921 and one untitled and undated preliminary plan were found in the files of the NHWRB.

2.3 Operation

No written engineering operational data for the hydropower operations have been prepared. Oral instructions have been in effect during the history of the operations. These instructions are transmitted from supervisors to subordinates.

a. Availability. A search of the files of the New Hampshire Water Resources Board (NHWRB) and direct contact with the owner, revealed only a limited amount of recorded information concerning the above elements.

b. Adequacy. The final assessments and recommendations of this investigation are based primarily on the visual inspection and the hydrologic and hydraulic calculations.

c. Validity. Because of the flow over the dam at the time of the inspection, field measurements could not be taken to validate many reported dimensions and elevations.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Pierce Power Dam is a run-of-the-river, low concrete dam which impounds a reservoir of small size. At the time of the inspection water was flowing over part of the dam, where the flashboards were either not in place or knocked over; little or no water was flowing over the remainder of the dam where flashboards were in place (See Appendix C, Figure 2.)

b. Dam. Pierce Power Dam is a concrete gravity dam approximately 28 feet high and 420 feet long. It consists of two sections: one section is a counterfort design with an inclined upstream face, about 168 feet long, at the west abutment (See Appendix C - Figure 3); the other section is a conventional gravity section with a vertical downstream face, about 122 feet long on a dogleg alignment, and extending from the counterfort section to the powerhouse on the east abutment. The concrete in the dam is deteriorated and coarse aggregate is exposed on the concrete face. The leading edge of the concrete piers have eroded up to 3 inches. (See Appendix C - Figure 4.) A concrete cap which has been added since the original construction shows placement of the concrete was difficult because of overflow; rags were placed in the forms to preclude washouts. (See Appendix C - Figure 5.)

About 260 feet of the entire length of the dam is an overflow spillway section. Flashboards about 2 feet high are in place along about 200 feet of the spillway section; over the remaining 60 feet of the spillway section the flashboard supports have been bent over to a horizontal position and some of the flashboards are missing entirely. At the time of the inspection, water was flowing over the failed flashboards or where they were missing but not over the upright flashboards. (See Appendix C - Figure 2.)

Bedrock is exposed at the downstream side of the overflow section along its entire length, and it appears that this section of the dam is founded on bedrock. No signs of significant leakage underneath the overflow section of the dam were noted.

Between the end of the overflow section and the powerhouse there is a knob of high ground which separates the main channel from the tailrace. The dam in this section consists of a low structure, having the appearance of a retaining

wall, built against the upstream side of the knob. It could not be determined from the visual inspection whether this wall is founded on soil or bedrock. A large quantity of seepage, approximately 50 gpm, was discharging from the soil and rock adjacent to the west side of the powerhouse structure downstream from this wall (See Appendix C - Figure 6). The discharge water was clean. The elevation at which the water discharged was about 13 feet below reservoir level and 10.5 feet above tailwater level in the tailrace.

At the west end of the dam, there is a concrete training wall which extends upstream and downstream of the dam. A short embankment section from the retaining wall forms the abutment, and a 20-inch wide cutoff wall extends about 25 feet from the training wall through this embankment to the abutment. The abutment itself is soil. No information was disclosed in the available records to indicate whether the cutoff wall is founded on soil or bedrock. No seepage was observed on the downstream side of the abutment.

At the east end of the dam is a powerhouse with retaining walls which retain the earthfill between the powerhouse and the abutment. A substantial amount of efflorescence on the concrete was noted on the downstream side of the powerhouse. (See Appendix C - Figure 7) The abutment itself is soil. There is no information in the available records to indicate whether the powerhouse or the retaining walls are founded on soil or rock. Minor seepage was discharging near the east side of the powerhouse.

c. Appurtenant Structures. Visual inspection of the gate structure on the upstream face of the powerhouse was limited to the visible portion above the water line. The leading edges of the gate intake structure have deteriorated and reinforcing steel is exposed above the water line. (See Appendix C - Figure 8.) Portions of the gate support walls have eroded up to 3 inches. Limited areas of the concrete walkway in front of the trash racks have also eroded, exposing some of the reinforcing steel in the deck. The submerged condition of the gates prevented inspection; however, the gate operating mechanisms were noted to be in good condition. (See Appendix C - Figure 9.)

The downstream face of the powerhouse was observed as having been recently repaired. It was also noted that the minor cracking in the gunite repair was causing efflorescence. (See Appendix C - Figure 7.) Some erosion of the concrete wall of the powerhouse tailrace was also noted.

A concrete training wall holds the west side of the knob of high ground downstream of the crest. The concrete has an eroded face. The downstream end section of the retaining wall has failed and tipped over into the channel. Because this wall is approximately 30 feet downstream of the dam the failed portion does not appear to have affected the integrity of the dam.

The powerhouse contains one 176-kw and one 500-kw capacity generator with vertical axis turbines which were operating and in good condition.

d. Reservoir Area. The reservoir behind Pierce Power Dam extends upstream about 900 feet to the Monadnock Power Station Dam. State Route 31 bridge crosses the reservoir between the two dams (See Appendix C - Figure 10.). The drainage area upstream of the dams is rolling and is generally covered with forest. It was not possible to see beneath the reservoir surface to determine how much silt was accumulated in the reservoir behind the dam.

e. Downstream Channel. The tailrace downstream of the powerhouse is narrow with some small trees up to several inches in diameter overhanding the channel. It joins the main channel about 600 feet downstream of the dam. (See Appendix C - Figure 11.) Tailwater covers the channel bottom, and it was not possible, on the basis of the visual inspection, to determine whether the bottom of the channel was bedrock or soil.

The channel downstream of the overflow section of the dam is wide and unobstructed. The channel bottom is bedrock and is covered with many large boulders. (See Appendix C - Figure 12.)

3.2 Evaluation

Based on the visual inspection, Pierce Power Dam appears to be in poor condition.

A large seepage adjacent to the west side of the powerhouse and a minor seepage adjacent to the east side of the powerhouse could lead to stability problems if not corrected.

The concrete in the dam is badly deteriorated, and coarse aggregate is exposed.

The flashboards are in generally poor condition, some have been bent over to a horizontal position along part of the length of the crest, and some are missing. This condition is normal in the spring. The ice thaw takes out the flashboards annually.

Extensive efflorescence of the concrete was noted on the downstream side of the powerhouse.

The end section of the training wall on the west side of the main downstream channel has been undermined and has tipped over into the channel. The chief plant engineer states that this section was originally built to protect a power pole from high tailwater. Sufficient wall remains, and therefore the wall has not been replaced.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

Although no written operational procedures have been developed for Pierce Power Dam, Messrs. Gordon Bishop, Chief Engineer and George Edwards, Maintenance Superintendent, are fully familiar with the operational procedures of their four dams, Powder Mill Pond, Monadnock Power, Pierce Power and Paper Mill, and the appurtenant facilities including the operations for hydropower generation. Mr. Bishop maintains complete records of all maintenance performed including cost records and operates on an annual budget. Each summer maximum releases of water from Powder Mill Dam are made and power is generated for a period such that the Powder Mill Reservoir is drawn down to about two feet below the concrete crest. This provides additional storage enabling the lower three dams to be drawn down. The gates at Powder Mill are then closed and the lower three dams are drained for inspection and repair. These three lower dams are dry for a week to 10 days. This procedure is usually accomplished in July. Accumulated sediment which has built up behind these dams passes downstream through the waste or head gates. At Pierce Power Dam it is through the latter.

4.2 Maintenance of Dam

Monadnock Paper Mills is responsible for the maintenance of Pierce Power Station Dam. Flashboards are repaired or replaced each summer. Inspection and repair to concrete below normal water surface is accomplished during drawdown. No written maintenance program has been prepared. Maintenance is performed as required; larger items are budgeted and scheduled for completion annually.

4.3 Maintenance of Operating Facilities

The annual releasing of sediment through the head gates enables the testing of the operating facilities to ensure they are functional.

4.4 Description of Any Warning System in Effect

A gage is located on the downstream face of the road crossing located approximately 2,200 feet downstream of Paper Mill Dam. During floodflow periods (usually occurring each spring) when the water reaches 3 feet on the downstream tailwater gage (0' at gage=598' MSL) below Paper Mill Dam, a flood watch around the clock is initiated by maintenance personnel. Two men ride up and down the road along the stream to observe conditions. Evacuation of the plant would be ordered when the flood exceeds 7 feet on this gage as the plant is flooded at 8' on the gage.

Maximum power is generated during this flood watch. Maximum tailwater observed in the last twenty years was 7.5 feet. This resulted in water up to but not in the paper mill plant. Records of all past flooding events are maintained. Flood warning and flood emergency procedures have not been written. Coordination of procedures is made through Civil Police and Civil Defense.

4.5 Evaluation

Reliance on oral instructions for maintenance and operations is not altogether satisfactory. The present operational and maintenance procedures are adequate to ensure that minor problems encountered are remedied within a reasonable amount of time. However, certain major problems require more than the normal operation and maintenance procedures.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Pierce Power Dam is a run-of-the-river dam having relatively little surcharge storage and high spillage. It is a concrete dam consisting of counterfort and gravity sections. The reservoir pool extends to the Monadnock Power Station Dam located about 900 feet upstream as the spillway crest elevation (without flashboards) is about 3.5 feet above the downstream toe of the Monadnock Power Station Dam.

b. Design Data. No recorded hydrologic or hydraulic design data were disclosed for Pierce Power Dam.

c. Experience Data. Low flow and flood profiles for the 1936 and 1938 floods are shown on the Contoocook River, New Hampshire, Plan and Profile, Sheet No. 5 of 7, February 1939, Revised February 1951, U.S. Engineer Office, Boston, Massachusetts (See page B-11.)

d. Visual Observations. At the time of inspection, no visual evidence was noted of damage to any portions of the concrete structure caused by excessive discharges.

e. Test Flood Analysis. Pierce Power Dam is classified as being small in size having a hydraulic height of 28 feet and a maximum storage capacity of 51 acre-feet. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was determined to be 1/4 PMF.

Using the 1/4 PMF, the test flood discharge was determined to be 15,758 cfs. The overtopping analysis indicates that the dam would be overtopped by 0.6 feet (5.1 feet above spillway crest without flashboards) during the test flood. The maximum spillway (without flashboards) capacity at top of dam is 10,245 cfs or 65 percent of the test flood discharge.

f. Dam Failure Analysis. The impact of failure of the dam at normal flow conditions and at top of dam were assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the Paper Mill Dam, a distance of approximately 1,150 feet. It was determined that a breach at top of dam would create the greater downstream impact. A breach at top of dam pool would increase the stage by 2.8 feet above the antecedent discharge stage of 6.2

feet causing appreciable damage to a house-restaurant building and the Paper Mill Dam resulting in the probable loss of 3 to 4 lives.

One should note because of the lack of storage behind the dam, that test flood flows discharging over the dam, assuming the dam did not fail, would have nearly the same effects on the downstream reach as a breach at maximum pool. As a result of the analysis described above, the Pierce Power Dam was classified Significant Hazard.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination indicates the following evidence of potential stability problems:

(1) Large seepage adjacent to the west side of the powerhouse, and minor seepage adjacent to the east side of the powerhouse.

(2) Deterioration of concrete in the dam.

(3) Efflorescence of concrete on the downstream side of the powerhouse.

b. Design and Construction Data. No design and construction data were available.

c. Operating Records. No operating records pertinent to the structural stability of the dam were available.

d. Post-Construction Changes. The downstream wall of the powerhouse and the retaining-wall section of the dam between the powerhouse and the overflow section of the dam have been gunited. A concrete cap has been constructed on the top of the overflow section of the dam.

e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATION, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that Pierce Power Dam is in poor condition at present. The most significant concern with respect to long term integrity of the dam is the large seepage (approximately 50 gpm) adjacent to the west side of the powerhouse.

The source of the leak could not be inspected because of the debris covering that portion of the downstream face. The classification of the dam's condition could be upgraded from poor to fair if the source of the leak could be found and properly repaired. The other major concerns with respect to the long-term integrity of the dam are.

(1) Deterioration of concrete in the dam.

(2) Efflorescence of concrete on the downstream side of the powerhouse.

(3) Small trees overhanging the tailrace.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the visual inspection. The results of the visual examination are adequate to make this assessment.

c. Urgency. The recommendations and remedial measures made in 7.2 and 7.3 below should be carried out by the owner within one year after the receipt of this Phase I report.

d. Need for Additional Investigation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.1.a above. These problems require the attention of a competent engineer who will have to make additional studies to design or specify remedial measures to rectify the problems. If left unattended, some of the problems could lead to instability of the structure.

7.2 Recommendations

The owner should retain the services of a Registered Professional Engineer to:

(1) Evaluate the seepages next to the powerhouse and to design remedial measures.

(2) Design and specify remedial repairs for the deteriorated concrete in the dam and appurtenant structures.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Remove debris from the downstream side of the retaining wall section of the dam immediately west of the powerhouse.

(2) Remove trees and brush from the banks of the channels for a distance of 50 feet downstream from the dam.

(3) Inspect the dam and monitor the seepage downstream of the dam once a week. (Initiate monitoring promptly.)

(4) Establish a written surveillance and warning program to follow in the event of emergency conditions.

(5) Engage a Registered Professional Engineer to make a complete technical inspection of the dam and appurtenant structures once every two years.

7.4 Alternatives.

None.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Pierce Power Dam, N.H. DATE November 20, 1978

TIME 11 AM

WEATHER Clear, cold

W.S. ELEV. U.S. 653.7 DN.S. 628

PARTY:

1. Warren Guinan
2. Robert Langen
3. Stephen Gilman
4. Leslie Williams
5. Robert Ojendyk
6. Ronald Hirschfeld
7. Harold Wilcox (1/3/79)
8. John Falcione (1/3/79)
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	R. Langen	
2.	Structural Stability	S. Gilman	
3.	Soils & Geology	R. Hirschfeld	
4.	Mechanical	J. Falcione	
5.	Electrical	H. Wilcox	
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Pierce Power Dam, N.H. DATE November 20, 1979

PROJECT FEATURE Intake Channel & Structure NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Contoocook River
Slope Conditions	Good
Bottom Conditions	Not visible beneath pond surface
Rock Slides or Falls	None
Log Boom	None
Debris	Little
Condition of Concrete Lining	
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Top of leading edges of piers are spalled; concrete eroded below.
Stop Logs and Slots	Good; clear of debris

PERIODIC INSPECTION CHECKLIST

PROJECT Pierce Power Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good, no apparent movement
Spalling	1"-3" at leading edges of piers some wall areas recently gunited.
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	Little at hairline cracks on downstream face.
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None apparent - not inspected
Cracks	None
Rusting or Corrosion of Steel	Very little where embedded in concrete.
b. Mechanical and Electrical	
Air Vents	The mechanical gates were in good condition and operable. The wheels for the operating facilities have been removed and stored because of vandalism.
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Pierce Power Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Outlet Structure & Channel NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good
Rust or Staining	
Spalling	Very little - d/s face of building recently gunited.
Erosion or Cavitation	Some at water line
Visible Reinforcing	None
Any Seepage or Efflorescence	Little at hairline cracks, large seepage about 13 feet below water surface (est 50 gpm)
Condition at Joints	Good
Drain holes	None apparent
Channel	
Loose Rock or Trees Overhanging Channel	Some trees overhanging channel; boulders in channel
Condition of Discharge Channel	Good

PERIODIC INSPECTION CHECKLIST

PROJECT Pierce Power Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees overhanging channel, but channel is wide
Floor of Approach Channel	Not visible beneath pond surface
b. Weir and Training Walls	
General Condition of Concrete	Fair - top of weir recently recapped with concrete.
Rust or Staining	
Spalling	Entire d/s face has eroded to a depth of at least one inch.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None, but section of training wall has overturned (last section)
Trees Overhanging Channel	Some trees
Floor of Channel	Bedrock and boulders
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT Pierce Power Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Service Bridge NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	None
Anchor Bolts	None
Bridge Seat	None
Longitudinal Members	None
Underside of Deck	Not inspected
Secondary Bracing	None
Deck	U/s edge spalled with exposed reinforcing
Drainage System	None
Railings	None
Expansion Joints	None
Paint	None
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Not applicable
Condition of Seat & Backwall	Not applicable

PROJECT Pierce Power Dam

DATE November 20, 1978

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Not visible
Changes in Watershed Runoff Potential	None
Upstream Hazards	5 houses along State Route 31, approach channel and bridge.
Downstream Hazards	Paper Mill Dam about 1200 feet and Alberto's Restaurant about 1000 feet downstream.
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None

APPENDIX B

ENGINEERING DATA

NEW HAMPSHIRE
WATER RESOURCES
BOARD
CONCORD, N. H.

PROJECT PIERCE POWER DAM

SUBJECT Contoocook — BENNINGTON

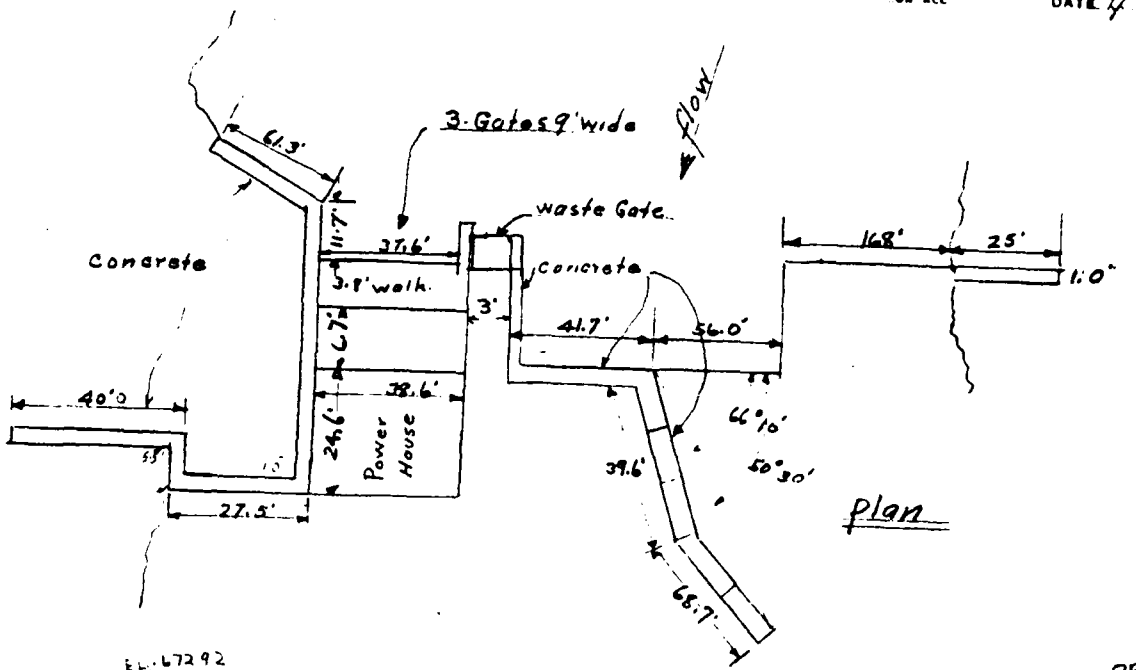
MERRIMACK Contoocook MONADNOCK PAPER MILLS CAUGHEY & PRATT Andover

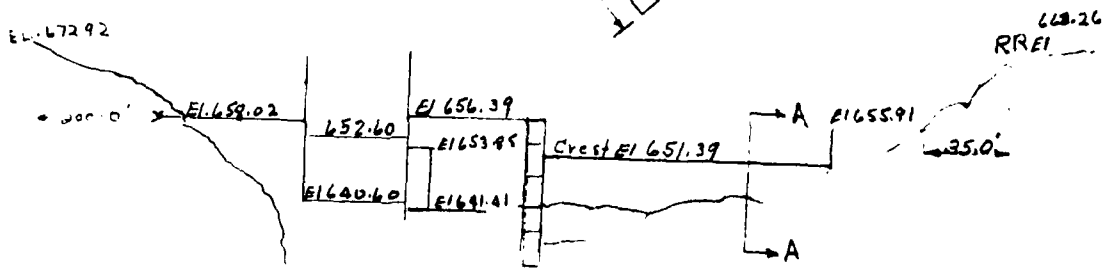
COMPUTER G.S.W. CHECKER A.R.R. CONT. FROM ACC. CONT ON ACC. SUMMARY ON ACC.

FILE 22.04

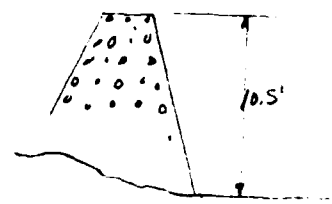
ACC.

DATE 4/7/39





ELEVATION Scale 1" = 60'-0"



Section A-A
Scale 1" = 10'-0"

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 02.04

Town Bennington : County Hillsboro

Stream Contoocook River

Basin-Primary Merrimack River : Secondary Contoocook River

Local Name Pierce Power Dam

Coordinates—Lat. 43° 00' ±1,250 ✓ : Long. 71° 55' ±2,250 ✓

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 132 Sq. Mi.

Overall length of dam 230 ft.: Date of Construction 1321

Height: Stream bed to highest elev. 13 ✓ ft.: Max. Structure 10.48 ✓ ft.

Cost—Dam ..... : Reservoir .....

DESCRIPTION C Type—Earth Concrete—Gravity

Waste Gates

Type .....

Number 1 : Size 8 ft. high x 11 ✓ ft. wide

Elevation Invert 10" ✓ : Total Area 88' ✓ sq. ft.

Hoist .....

Waste Gates Conduit

Number ..... : Materials .....

Size ..... ft.: Length ..... ft.: Area ..... sq. ft.

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width ..... : Elev. ..... ft.

Slopes—Upstream ..... on ..... : Downstream ..... on .....

Length—Right of Spillway ..... : Left of Spillway .....

Spillway

Materials of Construction Concrete

Length—Total ..... ft.: Net 258.3 ✓ ft.

Height of permanent section—max. 10.48 ✓ ft.: Min. ..... ft.

Flashboards—Type ..... : Height ..... ft.

Elevation—Permanent Crest ..... : Top of Flashboard .....

Flood Capacity 8010 cfs.: 41.7 cfs/sq. mi.

Abutments

Materials: .....

Freeboard: Max. 4.52 ✓ ft.: Min. ..... ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Monadnock Paper Mills-Cowley & Pratt ✓
Bennington, N H Antrim N H

REMARKS

Tabulation By C A N & R L T ✓ Date October 10, 1938 7/27/42

7266

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 22.04

Town Bennington : County Hillsboro

Stream Contoocook River

Basin-Primary Merrimack River : Secondary Contoocook River

Local Name Pierce Power Dam

GENERAL DATA

Head-Max. ..... ft.: Min. ..... ft.: Ave. 23 ft.

Date of Construction 1921 : Use of Power Hydro Electric Power - Paper Mill

Pondage ..... ac. ft.: Storage ..... ac. ft.

DESCRIPTION

Racks

Size of Rack Opening .....

Size of Bar ..... : Material .....

Area: Gross ..... Sq. Ft.: Net ..... sq. ft.

Head Gates

Type .....

Number 3 : Size 13' ft. high x 9' ft. wide

Elevation of Invert 10.79 : Total Area 324' sq. ft.

Hoist .....

Penstock

Number ..... : Material .....

Size ..... : Length .....

Turbines

Number 2 : Makers .....

Rating HP. per unit 1-800 H.P. 1-350 HP Total Capacity 800 HP.

Max. Dement C.F.S., per unit ..... : Total ..... cfs.

Drive

Type .....

Generator

Number 2

Make Westinghouse

Rating KW., per unit 1-500KVA -1-270KVA Total Capacity 2400 V 2400 V K. W.

Exciter

Number ..... : Make .....

Rating-per unit ..... : Total Capacity ..... K. W.

OUTPUT—KWHRS

19.....	..... :	19.....	.....
19.....	..... :	19.....	.....
19.....	..... :	19.....	.....
19.....	..... :	19.....	.....
19.....	..... :	19.....	.....

OWNER Monadnock Paper Mills -Caughey & Pratt Antrim N H

Tabulation By A A N & R L T AHS Date October 19, 1938 7/23/42

Form E80

NEW HAMPSHIRE WATER RESOURCES BOARD

QUESTIONNAIRE

WATER POWERS OF NEW HAMPSHIRE

Monadnock Paper Mills
Bennington
New Hampshire

Gentlemen:

We maintain in this office a list of the water power installations in New Hampshire. In recent months we have had several inquiries concerning the water power installations in the State and have found that our information is in some cases out of date.

We are, therefore, bringing this information up to date and request your cooperation by filling in the questionnaire below with data on your development, and return it to us in the enclosed stamped envelope.

Very truly yours,

R. S. Holmgren

RSH:GMB
Encl.

Richard S. Holmgren
Chief Engineer

Dam No. 22.04 : Location: Contoocook River at Bennington

1. Will you please check or correct:

	Our Data	Your Corrections
Drainage Area - Sq.Mi.	192	
Head - feet	25	2 x
Capacity (Total)	1150	2000 (?)
Wheel - H.P.		
Generator - K.W.		

2. Is the power plant now in operation? Yes

3. If not, is the equipment in operable condition? /

4. Is the dam in good repair? Yes

(Signed) A. F. Hall Treas

Date 7/23-42

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

RIVER Merrimack NO. 1 445 combined 22.04 192 Stafford
BASIN Contoocook DRAINAGE AREA SQ. MI. 1146.50 D. 1192 USGS list
TOWN Bequington OWNER Haile Bowen Manufacturing Mills Tax PSC
LOCAL NAME OF DAM Pierce Power Dam
BUILT 1921 DESCRIPTION Concrete Gravity

POOL AREA-ACRES GRAVITY STOR. POND CAPACITY-ACRE FT.
ELEVATION TOP OF DAM-F. 460± ELEV. TOP GATES-F.
LENGTH CREST ELEV. U.S.G.S. 451.31
SPILLWAY LENGTHS-FT. 258.3 & 160 FLASHBOARDS-NO. 1.52
FLASHBOARDS - TYPE, LENGTH & HEIGHT
WASTE GATES-NO. WIDTH HGT. OPENING CONTROL WHEEL

1	3.0	12.0	12.2	Hand
3	9.0	12.0	10.29	Hand

REMARKS 4I Original plans Aberthaw Const Co. Boston Mass in file
Condition Good

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW.	MAKE
		800	24 USGS list			Vertical
		1200	14 PSC			
	1	800?	25		500 KVA	Westinghouse 2400 V 120A 150RPM.
	1	350?	35 Braid		270 KVA	" 2400 V 53A 225RPM

USE Hydro Electric Power for paper mill both vertical units.

REMARKS Accompanying sketch copied from Army Engineers file notes
Primary H Station - river Pool
Power dam & power house erected 1921 at site of #4. #5 abandoned but surface of #4 excavated to foot of #5.
Plans by Aberthaw Construction Co. Boston in file.
Information from Braid, Chief Engineer. Did not know size or make of water wheels.
10/4/37 HH & J.H.S.

1925 PSC

DATE

DAMS AND THEIR LOCATIONS IN TOWN OF Bennington

No.	Location River, Brook, Pond or Lake		Condition Ruins or Operable	Owner	Owner's Address
1.	Powder Mill Dam	Lake	Concrete	Monadnock Paper Mills	Bennington
2.	Monadnock Power Station Dam	River	"	"	"
3.	Pierce Power [redacted]	River	"	"	"
4.	Paper Mill Dam	River	"	"	"
5.	)				
6.	) Three Dams on two brooks		Operable	Town of Bennington	
7.	) Town Water works				
8.	Lake George		Non-operable	Monadnock Paper Mills	"
9.					
10.					
11.					
12.					
13.					

Arthur J. Pierce
Selectman

Town No 4-5

Town Bennington No 1.6

Data by U.S.G.S. File 1-1142

Owner [redacted] Monadnock Paper Mills

River or Stream Contoocook River

Public Utility No Drainage area 132 sq. mi.

Wheel Capacity H. P. 130 { Primary H. P. / 90% time } 90.4

Type of Construction Concrete

Height 14 ft. Operating Head 14 ft.

Length 272 ft. Spillway Length No. 1 164 ft. (No 2) 108 ft.

Would Failure of Dam do Harm? Yes

Present Condition Fair Date ~~1922~~ 1922

1924 LWB Good ~~1925~~ 1925

Town No. 6 Town Bennington No. 1.6

Data by L.W.B. File

Owner Monadnock Paper Mills

River or Stream Contoocook River

Public Utility No Drainage area 184 sq. mi.

Wheel Capacity H. P. 735 { Primary H. P. / 90% time } 185.7

Type of Construction Concrete

Height 10 ft. Operating Head 30 ft.

Length 200 ft. Spillway Length (No. 1) 150 ft. (No. 2) ft.

Would Failure of Dam do Harm? No

Present Condition Fair Date 1922

1924 LWB Good 1925

MEMORANDUM

Accompanied by Commissioner Storrs I looked over the dam of the Monadnock Paper Mills known in the Commission's town dam file as No. 4.

This water privilege was purchased of the Antrim-Bennington Electric Light & Power Company. The dam was constructed in 22 [illegible]

As constructed, it does not exactly follow the blue print dated April 20, 1921, and marked preliminary, that was furnished by the Aberthaw Construction Company.

The dam was constructed across the entire width of the Contoocook River in two sections; one on the west bank upstream from the section connected with the power house. The old head gate and the stone wall in which it was placed has been removed. This formerly ran about one-third of the way across the river where it joined a wooden dam. This too has been removed. The new cement section was placed downstream from the old wooden structure.

This dam is now completed.

DWW:EVW D. W. W.

May 23, 1923

MEMORANDUM.

On July 28, 1921, I visited Bennington, New Hampshire, at the site of the old electric plant of the Antrim-Bennington Electric Light and Power Company. The old power house, and the wooden part of the dam adjoining the same have been removed. Extensive blasting operations for the new wheel pits have been practically completed. The new dam will set on solid ledge its entire length. Only the removal of some semi-loose ledge at the toe of the dam is necessary before actual construction of the dam can begin. Work is also progressing on the tail race.

DWW:DLM

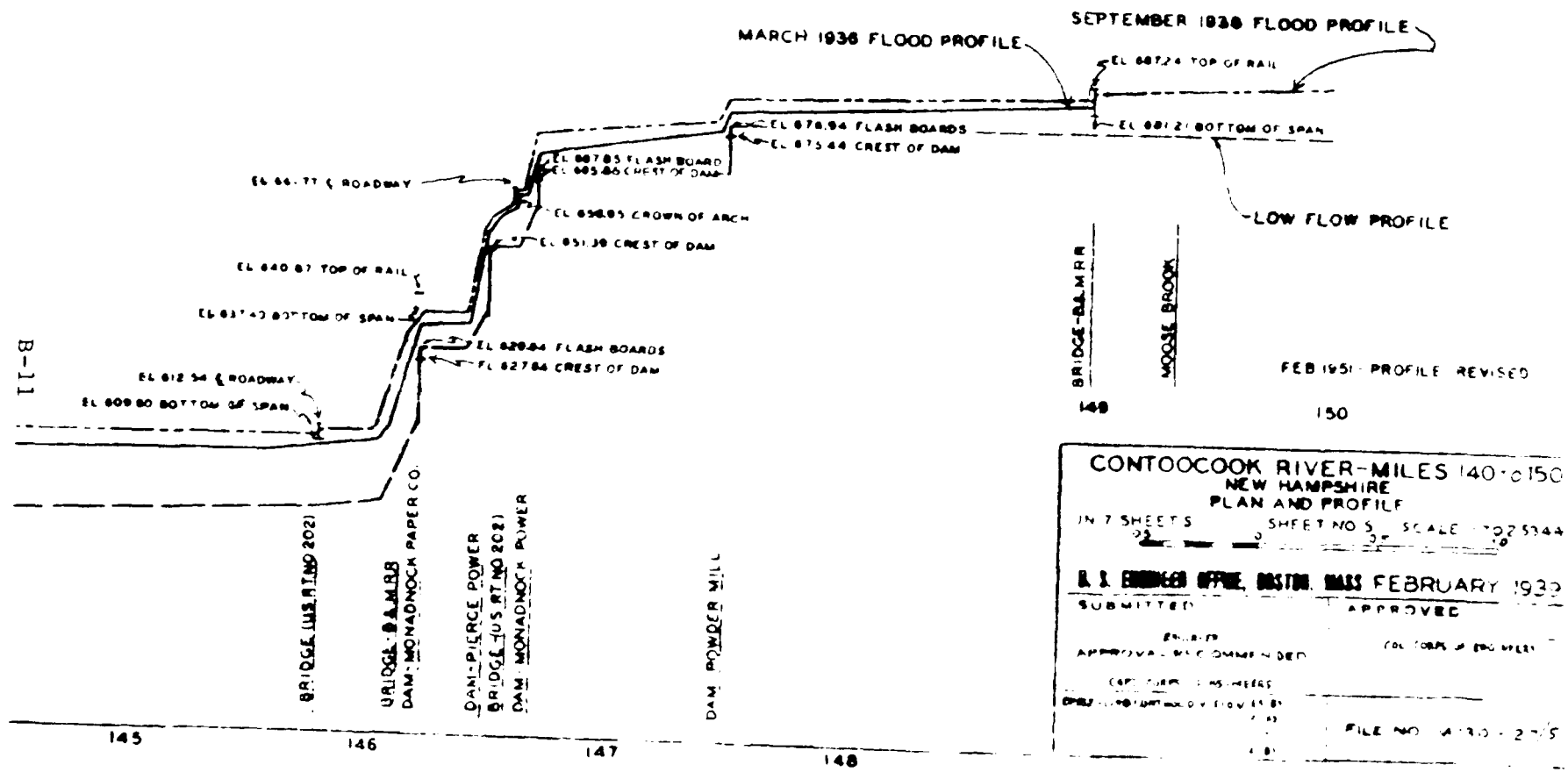
~~July 28, 1921~~
July 28, 1921

NEW HAMPSHIRE WATER CONTROL COMMISSION

Dams on which Information is Available in the

Town of Bennington

State No.	Location Stream	Name of Body of Water Created	Owner	Condition
22.01	Nameless Bk.	Whittemore Lake	A.J. Pierce	Ruin
22.02	Contoocook R.	Powder Mill Pond	Monadnock Paper Mills	Operable
22.03	Contoocook R.	---	Monadnock Paper Mills	Operable
~~22.04~~	Contoocook R.	---	Monadnock Paper Mills	Operable
22.06	Contoocook R.	---	Monadnock Paper Mills	Operable
22.07	Nameless Brook	---	J. Dow	Operable
22.08	Jakes Brook	---	Bennington Water Board	Operable
22.09	Cold Spring Bk.	---	Bennington Water Board	Operable
22.10	Cold Spring Bk.	---	Bennington Water Board	Operable



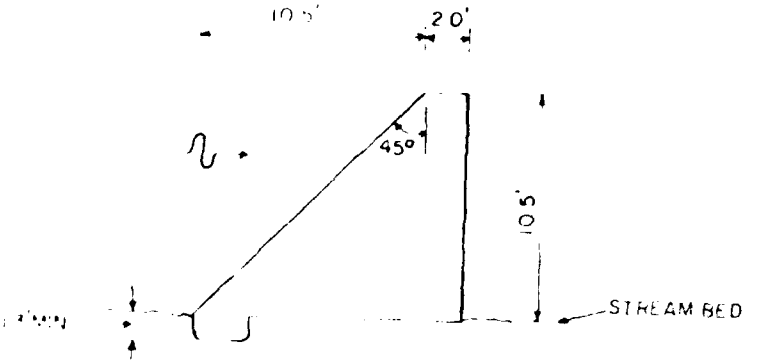
CONTOOCOOK RIVER-MILES 140 to 150
NEW HAMPSHIRE
PLAN AND PROFILE

IN 7 SHEETS SHEET NO 5 SCALE 1"=2000'=1 MILE

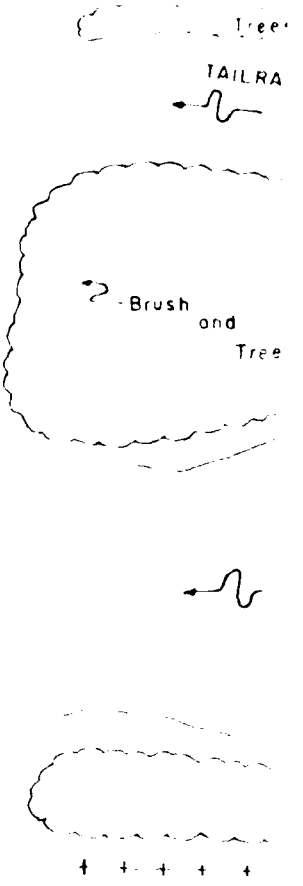
U. S. ENGINEER OFFICE, BOSTON, MASS FEBRUARY 1939

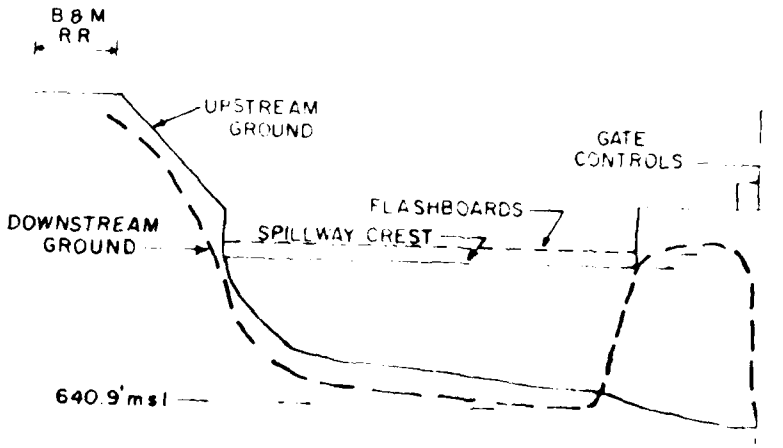
SUBMITTED APPROVED

FILE NO. 4-30-2-5

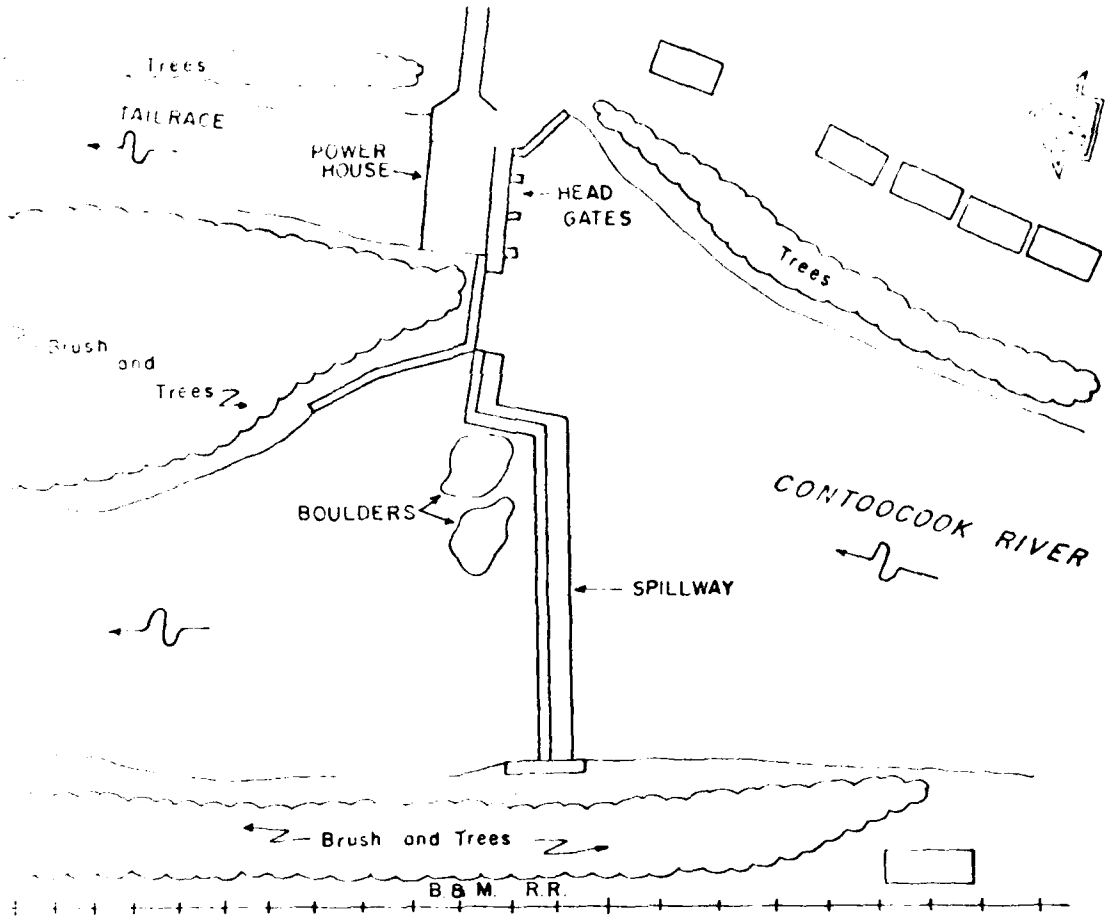


SPILLWAY SECTION

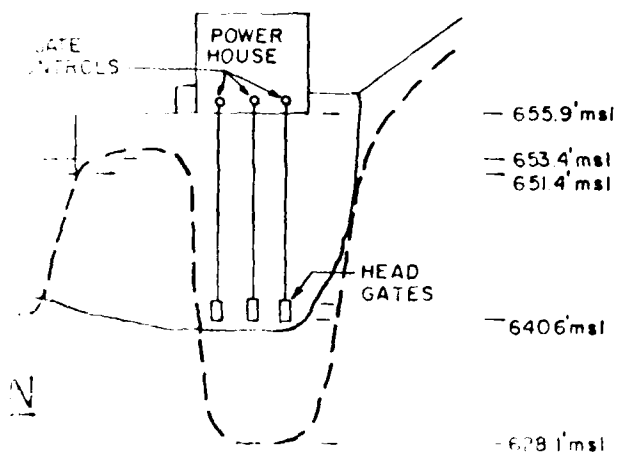




ELEVATION



PLAN



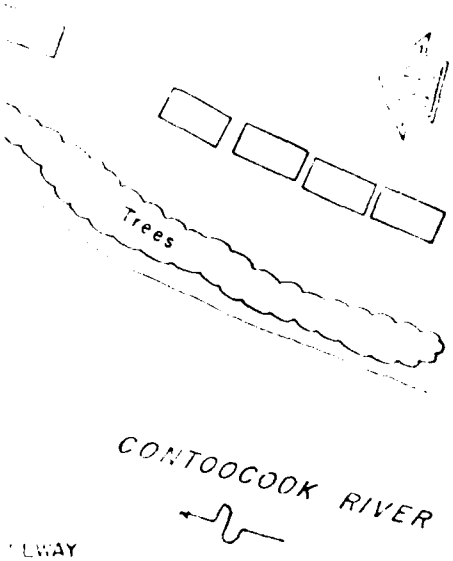
Anderson-Nichols & Co., Inc.	U S ARMY ENGINEER
CONCORD NEW HAMPSHIRE	CORPS OF ENGINEERS

NATIONAL PROGRAM OF INSPECTION OF NON-F

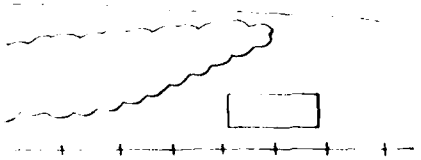
PIERCE POWER DAM

CONTOOCOOK RIVER NEW HAM

			SCALE NOT TO SCALE
			DATE FEBRUARY 19



SPILLWAY



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PIERCE POWER DAM

CONTOOCOOK RIVER NEW HAMPSHIRE

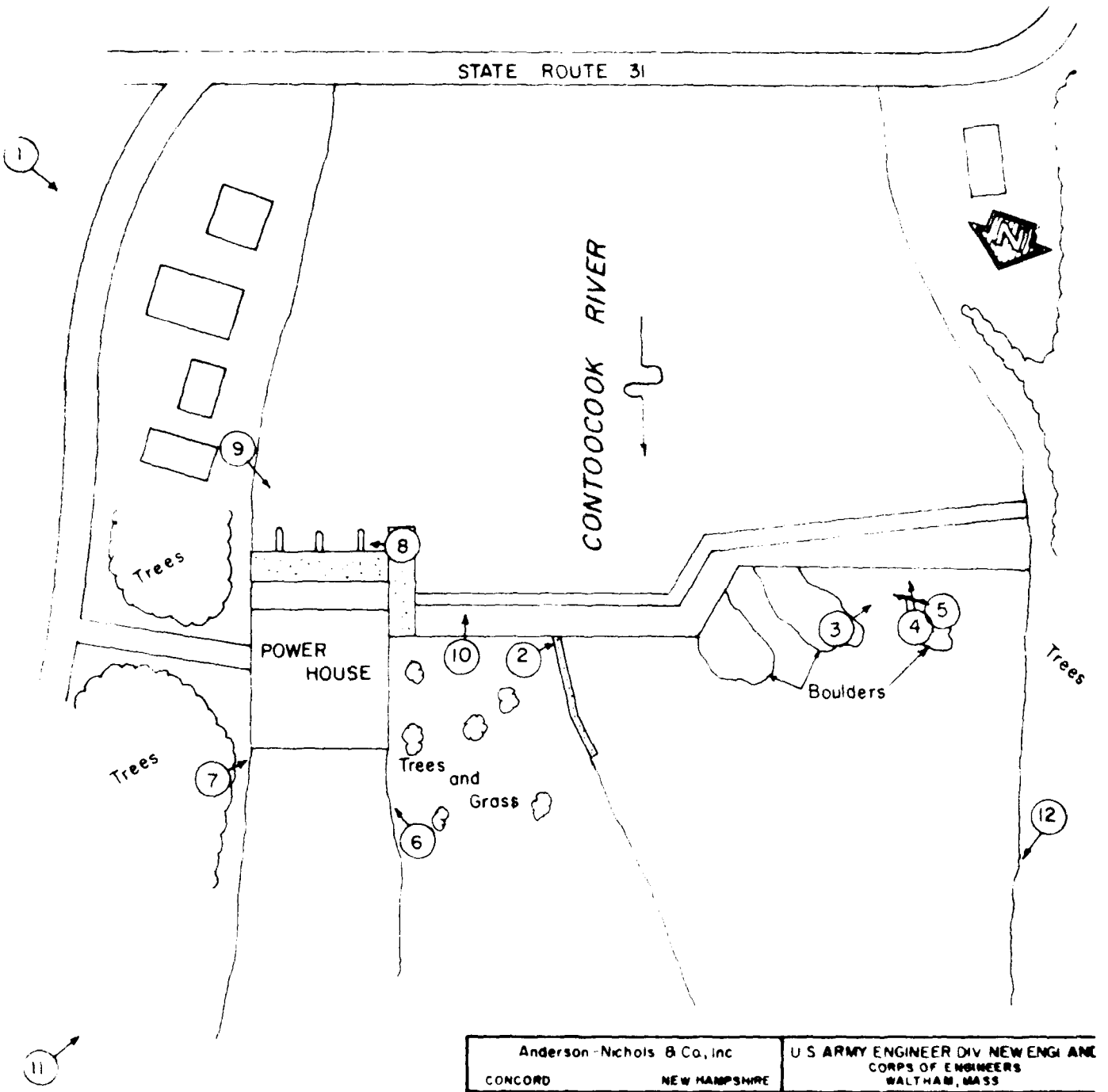
SCALE NOT TO SCALE

DATE FEBRUARY 1979

3

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PIERCE POWER DAM
PHOTO INDEX

CONTOOCOOK RIVER NEW HAMPSHIRE

			SCALE: NOT TO SCALE
			DATE: FEBRUARY 1979

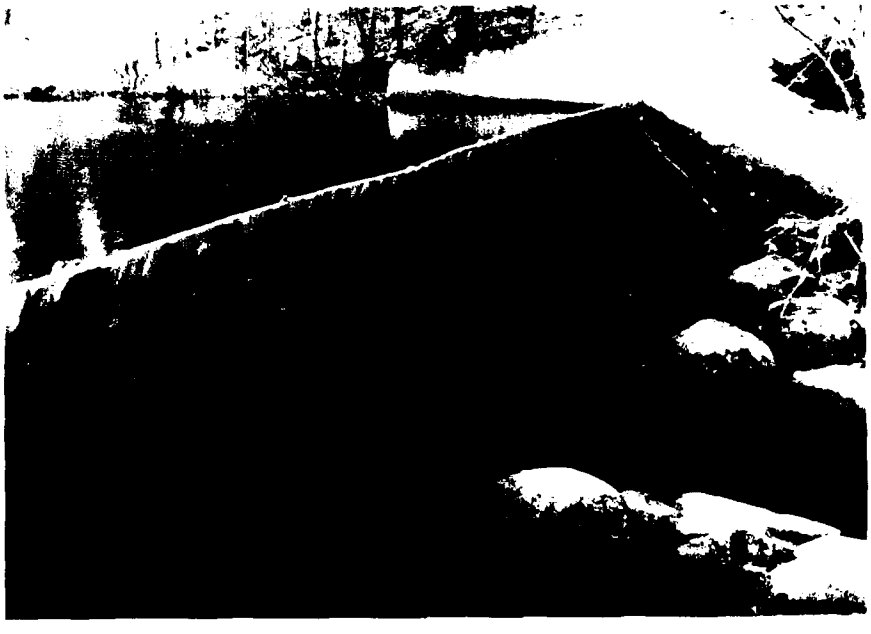


Figure 4 - Close-up of the exposed coarse aggregate on one of the counterfort piers.

Figure 5 - View of the concrete cap which has been added since original construction.

Figure 6 - Looking at the seepage discharging from the west side of the powerhouse.

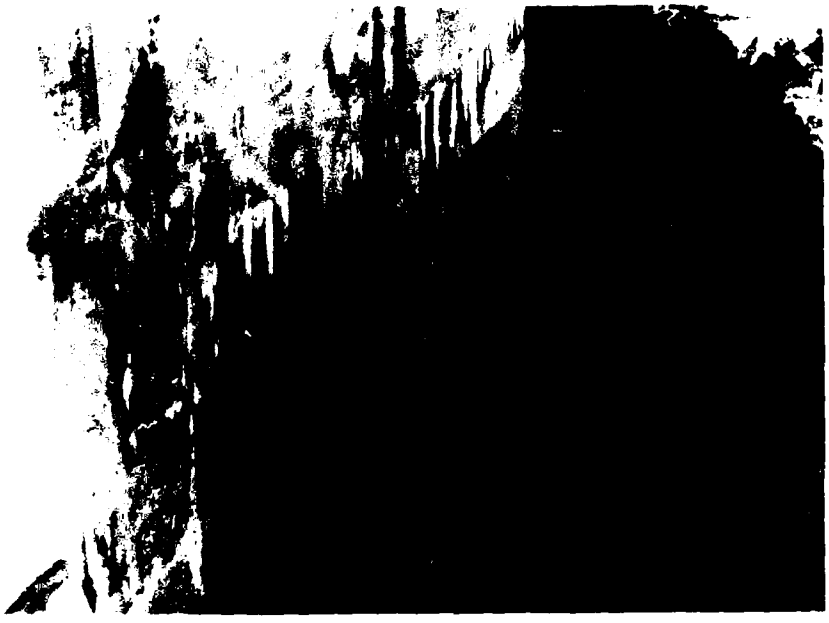


Figure 7 - Looking at the downstream face of the powerhouse. Note the efflorescence on the concrete.

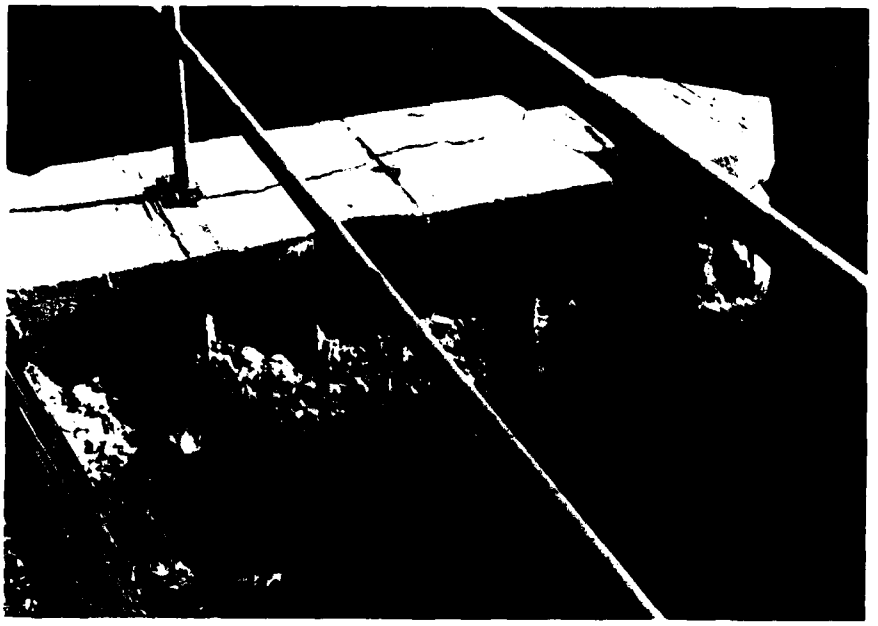


Figure 8 - Looking at the deteriorated leading edges of the gate intake structure. Note the exposed reinforcing steel.

Figure 9 - View of the gate mechanisms and trash racks located on the upstream face of the powerhouse.

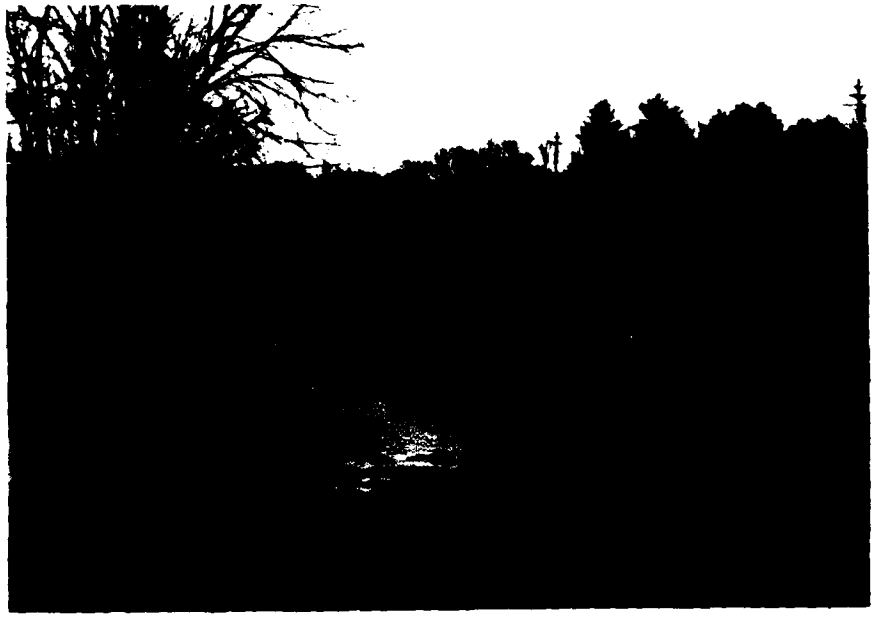


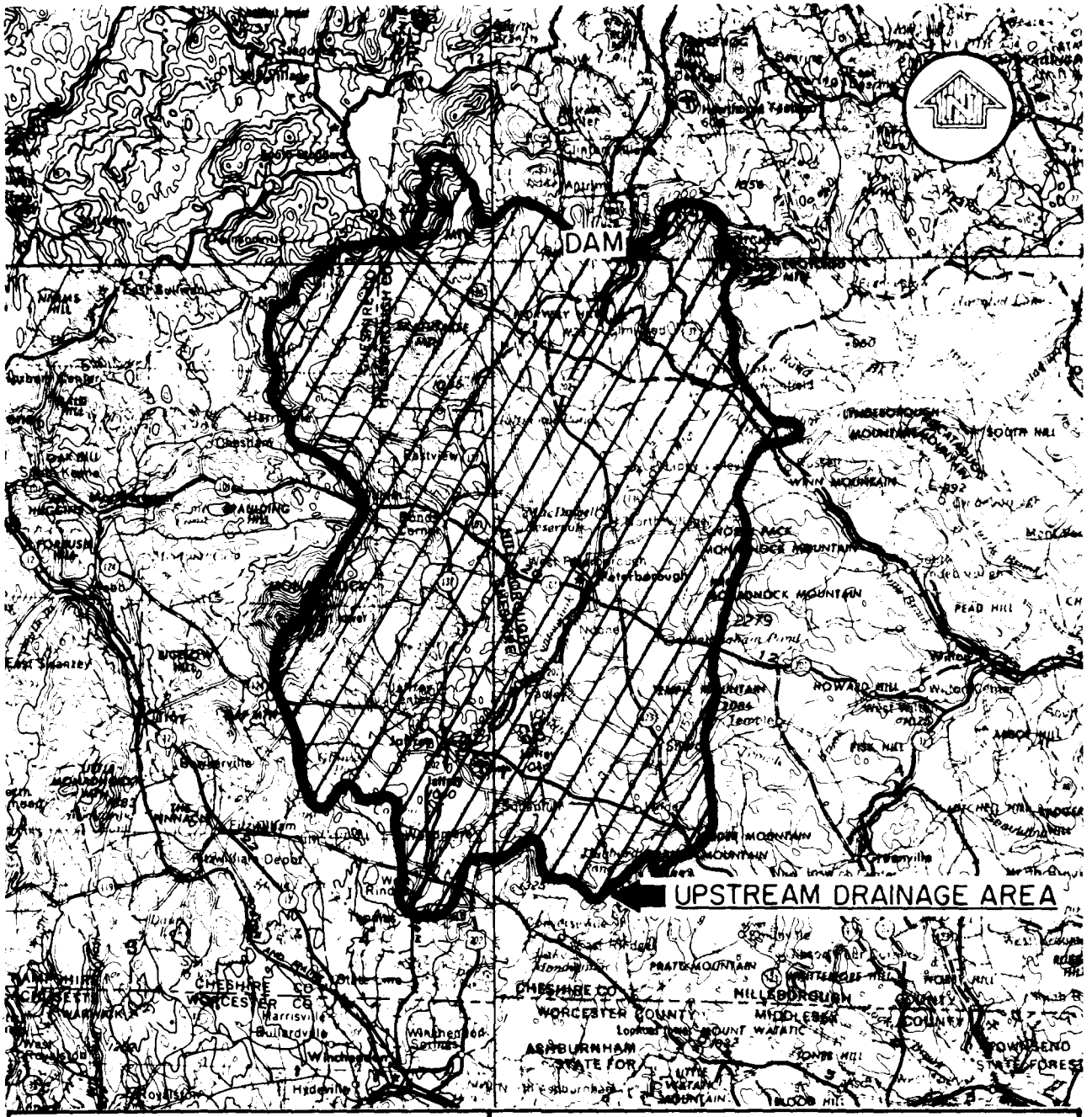
Figure 10 - Looking upstream into the reservoir from the dam.

Figure 11 - Overview which shows the tailrace on the left and the downstream channel on the right.

Figure 12 - Looking at the downstream channel of the overflow section.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PIERCE POWER DAM

BENNINGTON, NEW HAMPSHIRE

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, NH

SCALE IN MILES

0 5 10

MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING. ALBANY, NY, CT, MA, NH, VT, 1956. REV. 1974. BOSTON, MA, NH, CT, RI, ME, 1956, REV. 1970. PORTLAND, ME, NH. 1956, REV. 1972 GLENS FALLS, NY, VT, NH. 1956, REV. 1972.

SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

DA = 191 MI^2
SIZE CLASSIFICATION = SMALL
HAZARD CLASSIFICATION = SIGNIFICANT
INSPECTION FLOOD = $\frac{1}{4}$ PMF

STEP #1

CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978."

SLOPE OF CONTOOCOOK RIVER U/S OF PIERCE POWER STATION DAM ≈ 17 FT/MI., HOWEVER, BECAUSE OF CONSIDERABLE STORAGE AVAILABLE IN U/S LAKES AND PONDS THE MAXIMUM PROBABLE FLOOD PEAK FLOW RATE HAS BEEN SELECTED FOR FLAT AND COASTAL RATHER THAN ROLLING TERRAIN.

∴ FOR FLAT & COASTAL — DA = 19 MI^2
PMF = 330 CFS/MI^2

USE 1/4 PMF FOR PIERCE POWER STATION DAM

$\frac{1}{4} \cdot 330 \cdot 191 = 15758$ CFS

PEAK INFLOW = 15758 CFS ←
($\frac{1}{4}$ PMF-TEST FLOOD)

DEVELOP A DAM DISCHARGE RATING CURVE

ASSUME: C = 3.7 (SPILLWAY W/O FLASHBOARDS)
GATES CLOSED TABLE 5-11 (KING'S BRATER)
DA = 191 MI²
SPILLWAY @ ELEV 651.4 MSL

STEP #2a: DETERMINE SURCHARGE HEIGHT TO PASS Q_{p_1} OF 15758 CFS

TRIAL #1 @ ELEV 655.9 MSL (LOW POINT BEFORE OVERTOPPING)

$Q_{sw} = C L H^{3/2}$ L = 290 FT
$= 3.7 \cdot 290 \cdot 4.5^{3/2}$ H = 655.9 - 651.4
$= 10242.8$ CFS = 4.5 FT

TRIAL #2 @ ELEV 658 MSL (TOP OF DAM)

ASSUME: C = 2.7 (EMBANKMENT)
C = 2.6 (BROAD CRESTED WEIR H > 2.5') TABLE 5.3 KING'S BRATER

$Q_{sw} = 3.7 \cdot 290 \cdot (658.0 - 651.4)^{3/2}$
$= 18193.5$ CFS

$Q_{weir} = 2.7 \cdot \frac{1}{2} \cdot 10 (658 - 655.9)^{3/2}$
$+ 2.6 \cdot 45 (658 - 656.4)^{3/2}$
$= 411 + 236.8 = 277.9$ CFS

$Q_T = 18194 + 278 = 18472$ CFS

TRIAL #3 @ ELEV 660 MSL

$$Q_{SW} = 3.7 \cdot 290 (660 - 651.4)^{3/2}$$
$$= 27062 \text{ CFS}$$

$$Q_{WEIR} = 2.7 \cdot \tfrac{1}{2} \cdot 20 (660 - 655.9)^{3/2}$$
$$+ 2.6 \cdot 45 (660 - 656.4)^{3/2}$$
$$+ 2.6 \cdot 75 (660 - 658)^{3/2}$$
$$- 2.7 \cdot \tfrac{1}{2} \cdot 22 (660 - 658)^{3/2}$$

$$= 224.2 + 199.2 + 558.9 + 106.9$$
$$= 1689.2 \text{ CFS}$$

$$Q_T = 27061 + 1689 = 28750 \text{ CFS}$$

USE THE ABOVE TRIALS TO ESTABLISH A RATING CURVE FOR PIERCE POWER STATION DAM W/O FLASHBOARDS

SURCHARGE HEIGHT (ELEVATION) TO PASS Q_{PF} OF 15758 CFS IS 656.5' MSL (REFER TO RATING CURVE ON PAGE D-6)

SPILLWAY CREST = 651.4 MSL

∴ SPILLWAY WILL BE OVERTOPPED BY APPROXIMATELY 5.1 FEET DURING THE TEST FLOOD (1/4 PROBABLE MAXIMUM FLOOD)

ES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
SCALE

ASSUME: SPILLWAY W/FLASHBOARDS
GATES CLOSED
DA = 191 mi^2
C = 3.2 (H ≈ 1' → 4') (F.C 5.3 King & Brater)
FLASHBOARD CREST @ 657.4 MSL
NORMAL STORAGE = 33 AC-FT

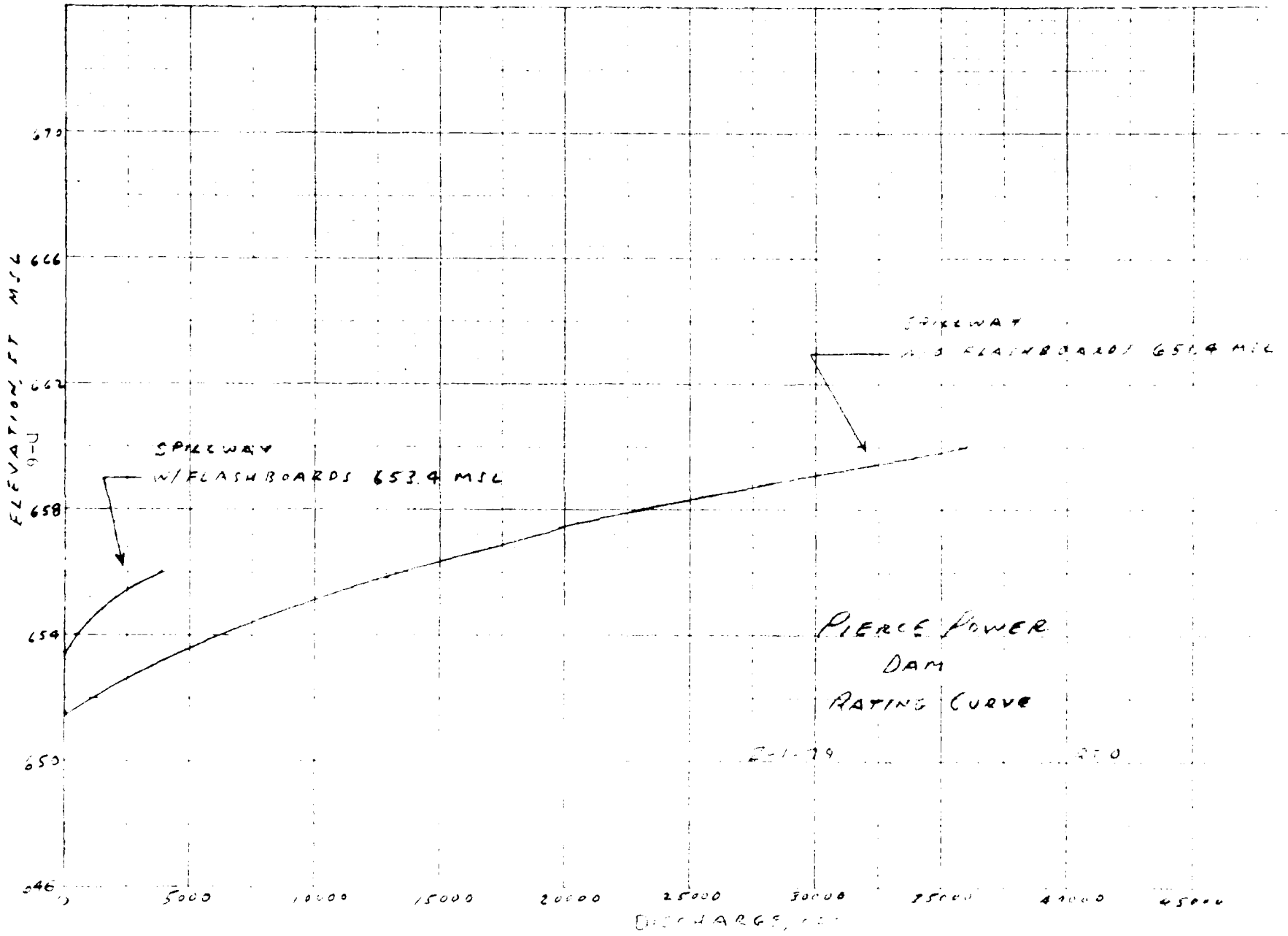
TRIAL #1 @ ELEV 654

$$Q_{sw} = 3.2 \cdot 290 \cdot (654 - 657.4)^{3/2}$$
$$= 431.3 \text{ CFS}$$

TRIAL #2 @ ELEV 656

$$Q_{sw} = 3.2 \cdot 290 \cdot (656 - 657.4)^{3/2}$$
$$= 3890.5 \text{ CFS}$$

USE THE ABOVE TRIALS TO ESTABLISH A RATING CURVE FOR PIERCE POWER STATION DAM W/FLASHBOARDS


ELEVATION, FT MSL
670
666
662
658
654
650
646
SPILLWAY
W/FLASHBOARDS 653.4 MSL
SPILLWAY
W/O FLASHBOARDS 651.4 MSL
PIERCE POWER
DAM
RATING CURVE
5000
10000
15000
20000
25000
30000
35000
40000
45000

USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE PAPER MILL DAM AND ESTABLISH A DISCHARGE RATING CURVE USING THE FOLLOWING MANNINGS EQUATION:

$$Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

n = COMPOSITE 'n' VALUE

A = AREA OF SECTION, FT²

R = HYDRAULIC RADIUS

$= \frac{A}{WP} = \frac{\text{AREA, FT}^2}{\text{WETTED PERIMETER, FT}}$

S = SLOPE OF REACH

LENGTH OF REACH = 1150'

ELEV @ D/S TOE = 641' MSL

ELEV @ END OF REACH = 618' MSL

$$S = \frac{641 - 618}{1150} = \frac{23}{1150} = 0.02$$

COMPOSITE 'n' = 0.09

THE TRIAL COMPUTATIONS BELOW REFER TO THE D/S HAZARD CROSS SECTION THAT IS SHOWN ON PAGE D-10.

Anderson-Nichols & Company, Inc.

JOB NO. 3220-12

SUBJECT FLOW AT PIERCE POWER DAM

2-29

BY [illegible]

CHECKED

SCALE

TRIAL #1 ASSUME STAGE @ 2'

$$A_1 = \frac{1}{2} \cdot 2 \cdot (150 + 220) = 370 \text{ FT}^2$$

$$WP_1 = 50 + 55 + 116 = 221 \text{ FT}$$

$$R_1 = \frac{370}{221} = 1.67$$

$$Q_1 = \frac{1.49}{0.09} \cdot 370 \cdot 1.67^{2/3} \cdot 0.02^{1/2}$$

$$= 1219 \text{ CFS}$$

TRIAL #2 ASSUME STAGE @ 4'

$$A_2 = \frac{1}{2} \cdot 4 \cdot (150 + 290) = 880 \text{ FT}^2$$

$$WP_2 = 150 + 110 + 30 = 290 \text{ FT}$$

$$R_2 = \frac{880}{290} = 3.03$$

$$Q_2 = \frac{1.49}{0.09} \cdot 880 \cdot 3.03^{2/3} \cdot 0.02^{1/2}$$

$$= 4314 \text{ CFS}$$

TRIAL #3 ASSUME STAGE @ 6

$$A_3 = \frac{1}{2} \cdot 6 \cdot (150 + 410) = 1530 \text{ FT}^2$$

$$WP_3 = 150 + 165 + 45 = 360 \text{ FT}$$

$$R_3 = \frac{1530}{360} = 4.25$$

$$Q_3 = \frac{1.49}{0.09} \cdot 1530 \cdot 4.25^{2/3} \cdot 0.02^{1/2} = 9219 \text{ CFS}$$

TRIAL #4 ASSUME STAGE @ 8'

$A_4 = \frac{1}{2} \cdot 8 \cdot (150 + 430) = 2320 \text{ FT}^2$

$WP_4 = 150 + 220 + 61 = 431 \text{ FT}$

$R_4 = \frac{2320}{431} = 5.38$

$Q_4 = \frac{1.49}{0.09} \cdot 2320 \cdot 5.38^{2/3} \cdot 0.02^{1/2}$

$= 16678 \text{ CFS}$

TRIAL #5 ASSUME STAGE @ 10'

$A_5 = \frac{1}{2} \cdot 10 \cdot (150 + 500) = 3250 \text{ FT}^2$

$WP_5 = 150 + 275 + 76 = 501 \text{ FT}$

$R_5 = \frac{3250}{501} = 6.49$

$Q_5 = \frac{1.49}{0.09} \cdot 3250 \cdot 6.49^{2/3} \cdot 0.02^{1/2}$

$= 26475 \text{ CFS}$

TRIAL #6 ASSUME STAGE @ 14'

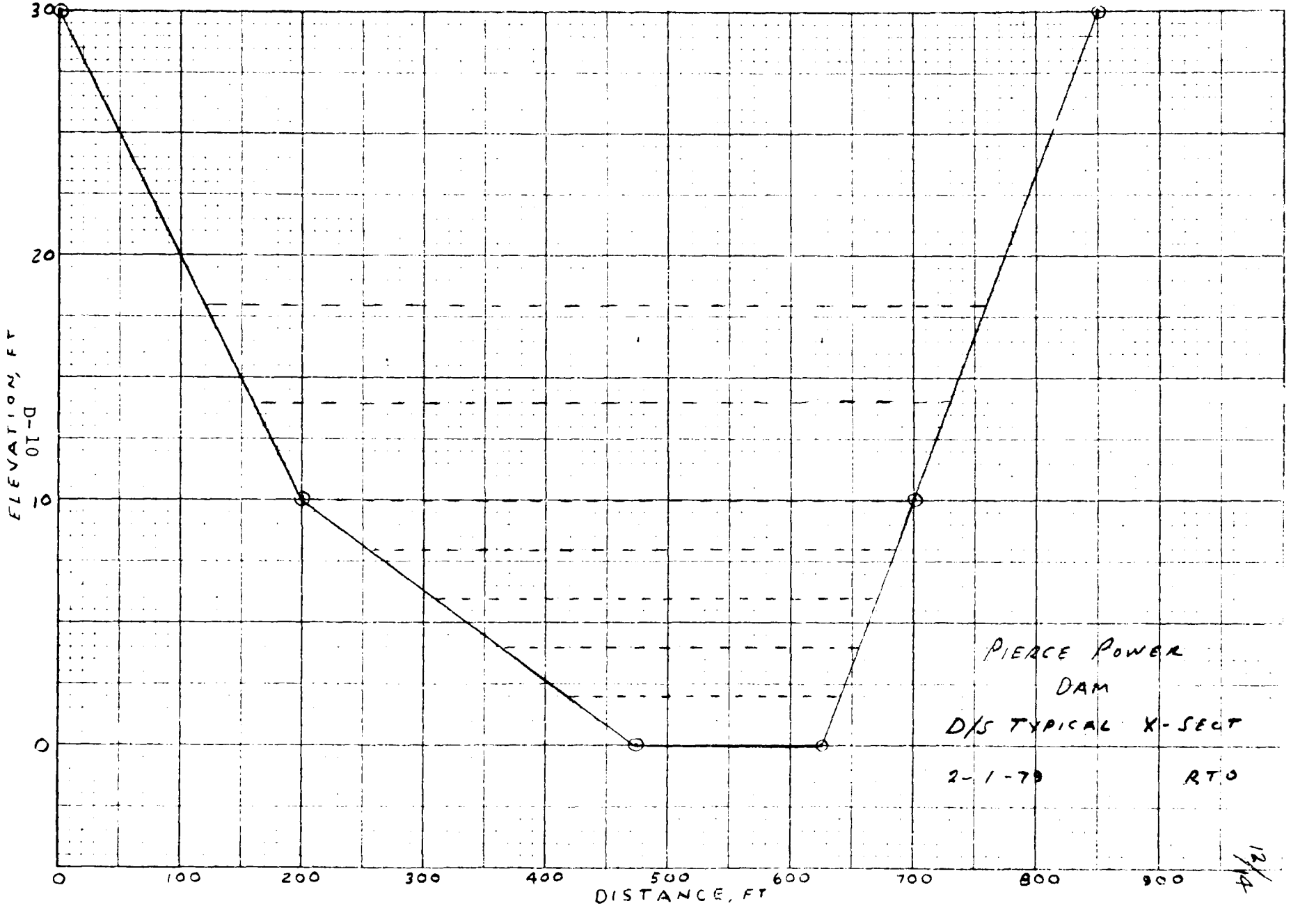
$A_6 = \frac{1}{2} \cdot 14 \cdot (150 + 570) = 5040 \text{ FT}^2$

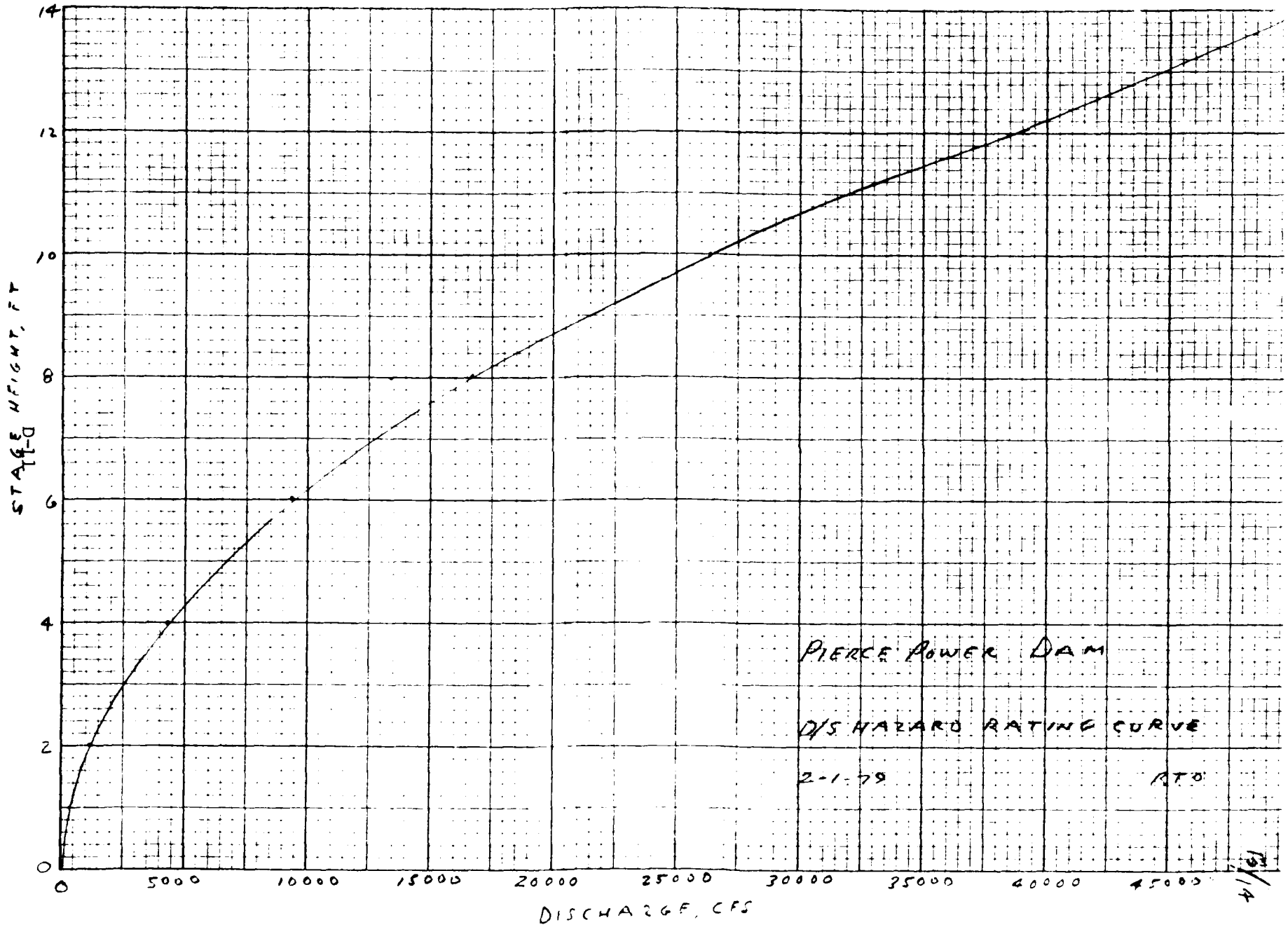
$WP_6 = 150 + 315 + 106 = 571 \text{ FT}$

$R_6 = \frac{5040}{571} = 8.83$

$Q_6 = \frac{1.49}{0.09} \cdot 5040 \cdot 8.83^{2/3} \cdot 0.02^{1/2}$

$= 50412 \text{ CFS}$


ELEVATION, FT
D-10
30
20
10
0
0
100
200
300
400
500
600
700
800
900
DISTANCE, FT
PIERCE POWER
DAM
D/S TYPICAL X-SECT
2-1-79
RTO
12/14


STAGE HEIGHT, FT
0
2
4
6
8
10
12
14
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
DISCHARGE, CFS
PIERCE POWER DAM
D/S HAZARD RATING CURVE
2-1-79
ATO
D-11
11/14

SQUARES 1/4 IN. SCALE

BREACH ANALYSIS

TO DETERMINE DOWNSTREAM HAZARD FAILURE OF THE DAM WILL BE CONSIDERED AT TWO DIFFERENT RESERVOIR POOL ELEVATIONS; I.E. (1) NORMAL POOL ELEVATION AND (2) TOP OF DAM POOL ELEVATION (MAXIMUM POOL/LOWEST NON-OVERFLOW POINT ELEVATION)

DETERMINE NORMAL FLOW CONDITION FOR CONTOOCOOK RIVER. (USING MEAN ANNUAL FLOW)

REFERENCE: WATER RESOURCE DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1976, U.S. GEOLOGICAL SURVEY WATER-DATA REPORT NH-VT-76-1, AUGUST 1977

AT GAGE STATIONS ON CONTOOCOOK RIVER:

DA = 68.1 MI^2 ; MAF = 144 CFS OR 2.11 CSM
DA = 368 MI^2 ; MAF = 858 CFS OR 2.33 CSM

DUE TO UPSTREAM STORAGE IN FOWLER MILL POND, 2.33 CSM IS APPLIED TO DA AT PIERCE POWER DAM (DA = 191 MI^2)

∴ NORMAL FLOW (MAF) = 191 · 2.33 = 445 CFS

FROM RATING CURVE FOR DAM WITH FLASHBOARDS (PAGE), DISCHARGE OF ~~445~~ CFS CORRESPONDS WITH ELEVATION OF 654.0' msl OR 0.6' OVER SPILLWAY WITH FLASHBOARDS

$$Q_{p_1} = \frac{8}{27} \cdot W_b \cdot \sqrt{g} \cdot y_0^{3/2}$$

Q_{p_1} = DISCHARGE THRU BREACH
W_b = BREACH WIDTH
g = 32.2 FT/SEC^2
y_0 = POOL ELEV - U/S RIVER BED

(1) NORMAL POOL ELEVATION
= 653.4 + 0.6 = 654.0' msl

U/S RIVER BED ASSUMED TO ≈ INVERT ELEVATION OF HEAD GATES
= 640.6' MSL

$W_b = 0.4 \cdot 420 = 168'$

$y_0 = 654.0 - 640.6 = 13.4'$

$$Q_{p_1} = \frac{8}{27} \cdot 168 \cdot 32.2^{1/2} \cdot 13.4^{3/2}$$

$= 13,855.5$ cfs

Q_2 = DISCHARGE OVER DAM THAT IS NOT BREACHED

$$Q_2 = C L H^{3/2} = 3.2 \cdot (290 - 168) \cdot 0.6^{3/2}$$

$= 181.4$ cfs

TOTAL BREACH Q = $Q_{p_1} + Q_2$

= 13,955.5 + 181.4

= 14,036.9 cfs

(2) TOP OF DAM POOL ELEVATION = 655.9' msl

$W_b = 0.4 \cdot 420 = 168'$

U/S RIVER BED ELEVATION = 640.6' msl

$y_o = 655.9 - 640.6 = 15.3'$

$Q_{p_1} = \frac{8}{27} \cdot 168 \cdot 32.2^{1/2} \cdot 15.3^{3/2}$

= 16,904.4 cfs

$Q_2 = C L H^{3/2}$ C = 3.7 (SPILLWAY W/O FLASHBOARDS)

$= 3.7 \cdot (290-168) \cdot (655.9-651.4)^{3/2}$

= 4309.0 cfs

TOTAL BREACH Q = $Q_{p_1} + Q_2$

= 16,904.4 + 4309.0

= 21,213.4 cfs

Anderson-Nichols & Company, Inc.

Subject H/H
PIERCE COVER DAM

Sheet No. ____ of ____
Date 2-79
Computed STO
Checked

JOB NO. 3220-12

FOR BREACH @ NORMAL FLOW CONDITION:

TOTAL BREACH Q (NORMAL) = 14,037 cfs
STAGE = 7.4' (REFER TO D/S HAZARD RATING CURVE ON PAGE D-11)

ANTECEDENT DISCHARGE: (WITH FLASHBOARDS)

$Q = CLH^{3/2}$
$= 3.2 \cdot 290 \cdot 0.6^{3/2}$
$= 431.3$ cfs
STAGE @ 431 cfs ≈ 1.0'

∴ INCREASE IN STAGE = 7.4 - 1.0
= 6.4'

FOR BREACH @ TOP OF DAM

TOTAL BREACH Q (TOP OF DAM) = 21,213 cfs
STAGE = 9.0' (REFER TO D/S HAZARD RATING CURVE ON PAGE D-11)

ANTECEDENT DISCHARGE:

$Q = CLH^{3/2}$
$= 3.7 \cdot 290 \cdot (655.3 - 651.4)^{3/2}$
$= 10,242.8$ cfs
STAGE @ 10,243 cfs ≈ 6.2'

∴ INCREASE IN STAGE = 9.0 - 6.2
= 2.8'

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(10) NAME	(11) LATITUDE (NORTH)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
NH	250	NED	NH	011	02				PIERCE POWER DAM	4300.2	7155.5	15FEB79

(14) POPULAR NAME	(15) NAME OF IMPOUNDMENT
	CONTOOCOOK RIVER

(16) REGION	(17) BASIN	(18) RIVER OR STREAM	(19) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(20) DIST FROM DAM (MI.)	(21) POPULATION
01	05	CONTOOCOOK	BENNINGTON	0	639

(22) TYPE OF DAM	(23) YEAR COMPLETED	(24) PURPOSES	(25) STRUCTURAL HEIGHT (FT.)	(26) HYDRAULIC HEIGHT (FT.)	(27) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(28) NORMAL (ACRE-FT.)
CTPG	1921	H	30	28	51	33

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	07MAR79

(29) REMARKS

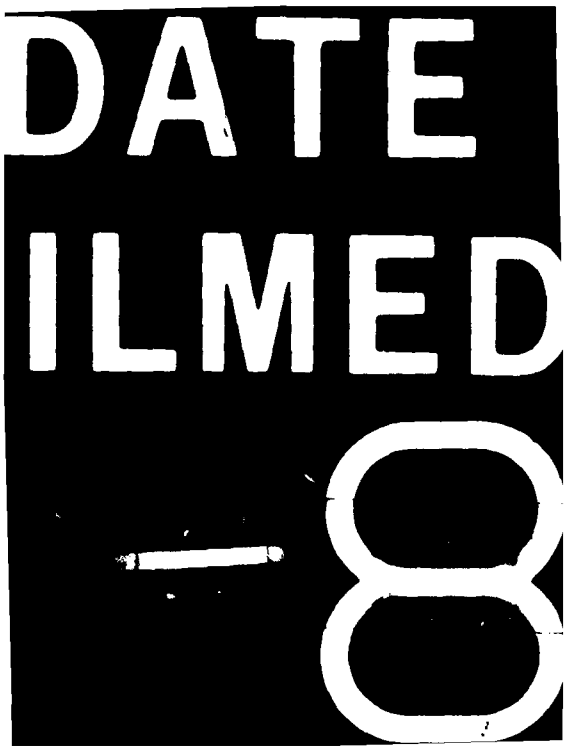
(30) D/S HAS	(31) SPILLWAY CREST LENGTH	(32) SPILLWAY TYPE	(33) SPILLWAY WIDTH (FT.)	(34) MAXIMUM DISCHARGE (FT.)	(35) VOLUME OF DAM (CY)	(36) POWER CAPACITY INSTALLED (MW)	(37) POWER CAPACITY PROPOSED (MW)	(38) NAVIGATION LOCKS NO.	(39) LENGTH (FT.)	(40) WIDTH (FT.)	(41) LENGTH (FT.)	(42) WIDTH (FT.)	(43) LENGTH (FT.)	(44) WIDTH (FT.)	(45) LENGTH (FT.)	(46) WIDTH (FT.)
2	420	C	290	10245		.7										

(47) OWNER	(48) ENGINEERING BY	(49) CONSTRUCTION BY
MONADNOCK PAPER MILLS		ABERTHAW CONSTR.CO

(50) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NHWRB	NHWRB	NHWRB	NHWRB

(51) INSPECTION BY	(52) INSPECTION DATE DAY | MO | YR	(53) AUTHORITY FOR INSPECTION
ANDERSON-NICHOLS + CO.,INC.	20NOV78	PL-92-367

(54) REMARKS


DATE
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-8